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TECHNOLOGIC PAPERS

OF THE

BUREAU OF STANDARDS

VOLUME 19

NOS. 273-301

DIV. II

F. S. Halbrook

DATE DUE

FEB 12 [redacted]			
GAYLORD			PRINTED IN U. S. A.

USE OF UNITED STATES GOVERNMENT SPECIFICATION PAINT AND PAINT MATERIALS

By P. H. Walker and E. F. Hickson

ABSTRACT

A brief description is given of the various materials covered by the specifications. It is believed that the existing specifications are sufficient for practically all necessary painting operations of the Government. The system of using semipaste paint, whenever possible, is recommended, and suitable thinning formulas applicable for the average painting condition have been developed. The proper method of breaking up and thinning stiff pastes in oil, semipastes, and mixed paints is discussed. The practical application of the various paints to all of the ordinary surfaces, such as wood, metal, cement, plaster, concrete, etc., is brought out and recommendations made. The care of brushes and the brushing of paint is described.

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I. GENERAL APPLICABILITY OF MATERIALS COVERED BY SPECIFICATIONS

The Federal Specifications Board has adopted as United States Government standards specifications covering materials used in mixing paint on the job, ready-mixed paints, and varnishes. These specifications do not attempt to cover all valuable painting materials, and many excellent types of finish are made with material not included. However, they furnish suitable material for such a large proportion of all necessary painting operations that it is believed that there is little need of the Government or any other large general user making material additions to this set of specifications. The most important exception to the above statement is ships bottom and boot topping paints. There are no Federal Specifications Board specifications covering such paints, and the United States Navy and United States Shipping Board are the best present sources of information on these types of materials.

Tinting colors, with the exception of ocher, are, as yet, not covered by Federal Specifications Board specifications. Such materials are

evaluated mainly on color strength and matching in color and tone some mutually agreed upon sample. Furthermore, tinting colors are used in such small amounts in any paint mixed on the job that their quality is of secondary importance. When such tinting colors are prescribed in any of the mixing formulas given in Table 1, it is safe to use material meeting any of the specifications in use by various branches of the Government service; in fact, almost any of the well-known brands will be satisfactory, provided the color and tone are satisfactory to the user.

Small quantities of materials should not be purchased under specifications. Orders should be large enough to justify the expense of sampling and testing of deliveries, and to base acceptance or rejection on tests of samples taken from such deliveries. It is seldom that such work can be properly done for less than $25. Samples should not be accepted before making contracts, except where such qualities as odor, color, strength, or finish are mutually agreed upon by buyer and seller, and these precontract samples should be considered only in regard to these specific points. The acceptance of a sample for such mutual agreement should not be taken as modifying any part of the standard specification.

Purchasing agents, inspectors, and users should have and read copies of all of these specifications. When obviously unsatisfactory material is submitted, a competent painter or inspector can in a large proportion of cases determine by inspection and careful reading of the specifications, without reference to a testing laboratory, that rejection is justified. Every person taking samples for submission to a laboratory for test should follow the detailed directions for sampling given in each individual specification.

II. COMMENTS ON INDIVIDUAL MATERIALS

1. LIQUIDS NOT USED ALONE

(*a*) Linseed Oil, Raw, Refined, and Boiled, F. S. B. No. 4, B. S. Circular No. 82.—Linseed oil is the most important liquid used in oil paints. The specification covers raw, refined, and boiled linseed oil. A very large proportion of linseed oil produced in the United States is crushed from Argentine seed. This oil from South American seed is generally characterized by a lower iodine number than that from North American seed. It is believed by many paint technologists that oil of high iodine number (like that from North American seed) is better drying oil than that of lower iodine number (like that from much South American seed). While the authors have doubts as to the correctness of this view, they are of the opinion that even if oil of high iodine number is not actually superior to oil of low iodine number, there is no evidence to indicate that it is

inferior to the latter. Hence, unless there is a material difference in price, it is advisable to purchase oil from North American seed. The bulk of linseed oil purchased by the Government is raw oil. There is some boiled oil purchased; but, judged by the samples sent to the Bureau of Standards for test, the amount of refined oil used by the Government is negligible. The quality of raw linseed oil is much more frequently influenced by the presence of excessive "foots"[1] than by actual impurities. Paint made with oil containing considerable "foots" is liable to dry very slowly and might be easily washed off even long after it is apparently dry. The specification gives a limit of 2 per cent of "foots" as determined by a method given in the specification. This "foots" will gradually settle to some extent; hence, one may draw off clear oil, meeting the specification, from the upper portion of a container and find oil with much foots near the bottom. It is well worth while to filter all linseed oil before using, especially if it is cloudy. With a 10-inch funnel and a 20-inch folded filter paper, one can generally filter a gallon of oil in about four hours. The operation is slow, but it requires very little labor, and it is believed well worth while. Raw linseed oil dries so slowly that it is necessary to use drier with it; the amount of drier necessary will be discussed later.

Boiled linseed oil differs from raw oil in that it contains metallic driers. In general, a mixture of raw linseed oil and liquid drier is as satisfactory as boiled oil. Boiled oil is, however, probably better in priming coats for plaster, cement, and brick, and a mixture of raw and boiled oil in priming coats for metal.

(*b*) Turpentine (Gum Spirits and Wood Turpentine), F. S. B. No. 7, B. S. Circular No. 86.—The specification covers both "gum spirits" and "wood turpentine." There is practically no difference in evaporation of the two types covered by the specification. There is evidence that wood turpentine in certain cases is a somewhat better solvent than gum spirits. The difference in solvent power is immaterial in thinning oil paints. In the manufacture of certain varnishes it is of importance. "Gum spirits," however, has a characteristic odor, which is not disagreeable to most people. Some highly refined "wood turpentine" has an odor that is hard to distinguish from "gum spirits," and some wood spirits have a very disagreeable odor. Hence, in specifying gum spirits it is unnecessary to agree upon any sample for odor, but in specifying "wood turpentine" it is advisable for buyer and seller to mutually agree upon a sample as standard for odor, with the proviso that no lot delivered shall have a more disagreeable odor than this sample. This sample is to be used as stand-

[1] "Foots" is a term applied to the solid or semisolid matter that settles out of the oil on standing. Its composition is quite variable, but it always contains some mucilaginous matter which is believed to hinder proper drying of the oil.

ard for odor only. The other requirements are to be as given in the specification. Turpentine can be used in all cases where a volatile thinner is used in oil paints. It is the best solvent for the oils, etc., occurring in woods; it has excellent penetrating qualities, and, hence, should be used in priming coats on new wood. There is no objection to using it in all subsequent coats, and where varnish is a constituent of the paint and additional volatile thinner is necessary it is safest to use turpentine.

(*c*) Volatile Mineral Spirits, F. S. B. No. 16, B. S. Circular No. 98.—This specification covers a petroleum distillate that evaporates in a manner similar to turpentine. It is not as good a solvent as turpentine, but can be used in many cases. Turpentine, therefore, is better as a volatile thinner in paints to be used as priming coats on resinous woods. In thinning varnishes with mineral spirits it is necessary to make sure that the particular varnish in question will readily mix with the mineral spirits. The reason for using mineral spirits is that it costs much less than turpentine. The production of turpentine is so limited that it is necessary to use other thinners whenever possible and in many cases mineral spirits is entirely satisfactory.

(*d*) Liquid Paint Drier, F. S. B. No. 20, B. S. Circular No. 105.—This specification calls for any suitable combination of one or more of the drying metals (lead, manganese, and cobalt) with oil or oil and resins. The composition is left to the manufacturer, provided the desired drying and other properties are obtained in the finished drier. Drier is added to promote the drying of the oil in paints, and should be used in the smallest possible amount that will produce the desired result; it should not be used in place of volatile thinner. For most purposes satisfactory driers can be made with a great variety of proportions of the drying metals. It is only in the special light-colored paints intended to be resistant to sulphide fumes that a drier meeting the general specifications may not be satisfactory. The drier used in these special paints should be free from lead, but otherwise meet the specification. The amount of drier used in paints varies somewhat; some pigments require more drier than others, and with paints containing essentially the same pigments more drier will be required for dark colors than for light colors.

(*e*) Composite Vehicle, F. S. B. No. 17, B. S. Circular No. 102.—The material procured under this specification is a composite vehicle for use in cheaper paints than straight linseed oil paints. It is intended for use as a single coat—generally in repainting jobs. It can be used with semipastes where these are specified. Generally a mixture of about equal volumes of the composite vehicle and the semipaste is satisfactory. While, as mentioned above, paints made with this composite vehicle are probably inferior to straight linseed

oil paints, excellent service is frequently had with them; for example, freight-car paints are often of this type.

2. PIGMENTS

The various pigment specifications call for the pigments either in the dry form or as pastes in linseed oil. With the exception of red lead, it is generally best to procure pigments in the paste rather than in the dry form.

(*a*) Basic Carbonate White Lead, F. S. B. No. 5, B. S. Circular No. 84, and Basic Sulphate White Lead, F. S. B. No. 6, B. S. Circular No. 85.—Since different lots of white lead are not always of the same color and strength, it is advisable to agree upon a sample to be used as standard for these points only. The specifications should hold in all other respects as regards deliveries.

White lead is the most important of the white pigments. It enters into most light-colored paints, and, in addition, it is the only white pigment that can be successfully used alone in white linseed oil paints intended for outdoor exposure. While both leads can be used, the basic carbonate is generally preferred. White lead-linseed oil paints spread and hide well, and dry to somewhat soft films, which do not generally decay by cracking, but chalk—a condition satisfactory for repainting. Owing to their softness, such paints show a greater tendency to take up dirt than harder paint films.

As indicated above, white lead can be used for a great variety of paints; hence, many mixing formulas can be successfully used. While many variations can be made and satisfactory results obtained, the formulas for making white lead paints, as given in Table 1, formulas 1, 2, 3, 4, 5, and 6 represent good average practice for most painting operations. Details as to methods of mixing for the various coats will be given after considering some of the other pigments. One hundred pounds of paste white lead occupies about $2\frac{2}{3}$ gallons; hence, in the formulas, the approximate volume of the paints produced can be obtained by adding $2\frac{2}{3}$ gallons to the sum of the volumes of the liquid constituents.

(*b*) Zinc Oxide, F. S. B. No. 8, B. S. Circular No. 87, and Leaded Zinc Oxide, F. S. B. No. 9, B. S. Circular No. 88.—Since different lots of zinc oxide and leaded zinc oxide are not always of the same whiteness and color strength, it is advisable to agree upon a sample to be used as standard only for these points. The specifications should hold in all other respects as regards deliveries. French-process zinc oxide is generally whiter than leaded zinc oxide. The latter is, however, generally somewhat whiter than white lead.

Zinc oxide in oil forms a paint that dries to a hard film that does not decay by chalking, but is liable to crack. While zinc oxide-linseed oil paints are said to have been successfully used in France

and some other parts of Europe, experience in America indicates that they are not satisfactory. It follows from the above that zinc oxide is not to be used alone in oil paints for outdoor exposure. It can be used alone in a varnish vehicle for the manufacture of high-grade enamels, but this is best carried out by an enamel manufacturer. Some so-called zinc oxide oil paints intended for outside exposure are sold in this country, but those that have been found satisfactory always contain large proportions of other pigments, generally white lead. Zinc oxide can advantageously be used with other pigments. With mildly chalking pigments, such as white lead, the hardening effect of zinc oxide is distinctly beneficial. With badly chalking pigments, such as titanium oxide pigment, the addition of zinc oxide is necessary to produce satisfactory paints. For the mixed pigment, oil paints for general use, the American process zinc oxide or the leaded zinc oxides can be used. For special oil paints to resist sulphide fumes and for the white enamels French process zinc oxide is to be preferred.

Different lots of zinc oxide vary to a great extent in their oil taking properties. It has been observed that some samples of zinc oxide pastes, conforming to the specifications and practically identical in composition, required three times as much linseed oil to reduce to brushing consistency in one case as in another. It is, therefore, evident that the formulas in Table 1 are mere approximations, and in preparing such paints, the operator must mix to brushing consistency, rather than attempt to hold fast to quantitative proportions. For mixtures of white lead and zinc oxide containing only small amounts of the latter (at least three times as much white lead as zinc oxide), formulas Nos. 1 to 5 given under white lead can generally be used. With mixtures containing more zinc oxide it is advisable to increase the proportions of turpentine and drier.

In Table 1, formulas 7, 8, and 9 give examples of lead-zinc paints made by mixing and thinning equal weights of white lead paste and zinc oxide paste. This proportion of zinc is generally considered the maximum amount advisable, and is particularly preferable around seashores and on boats. For places exposed to average weather conditions, three to four parts of the zinc oxide paste mixed with six or seven parts of the white lead paste make durable paints. One hundred pounds of zinc oxide paste occupies about 3¾ gallons; 100 pounds of paste, consisting of 50 pounds of white lead paste and 50 pounds of zinc oxide paste, occupies about 3¼ gallons; hence, the approximate volumes of the paints produced in formulas 8, 9, and 10 can be obtained by adding 3¼ gallons to the sum of the liquid constituents.

(C) Red Lead, F. S. B. No. 11, B. S. Circular No. 90.—Red lead is not used for its color; hence, there is no reason for agreeing upon any

precontract sample. The specification covers both dry red lead and red lead paste in linseed oil. It further covers red leads of 85 and 95 per cent grades. As regards the relative merits of dry versus paste red lead, it may be said that the paste is somewhat easier and safer to handle. On the other hand, paste lead may harden in the container; hence, it should be purchased only when it is known that it will be used in a short time. As a general rule it is therefore safest to stock the dry red lead instead of the paste. As to the relative merits of the 85 and 95 per cent grades, it is believed that, in general, the 95 per cent grade is not as liable to rapid heardening in the bucket and is likely to give smoother and more regular coats than the 85 per cent grade. Hence, unless there is a considerable difference in price, it is advisable to stock the 95 per cent grade. This statement as to the preference for the 95 per cent grade is to be taken only as generally true, for some samples of 85 per cent grade (probably unusually finely ground) are superior to some samples of 95 per cent grade (probably coarser than the average of this grade).

Red lead is probably the best widely used pigment for first coats on all kinds of surfaces. It is not commonly used in priming wood because its color makes it necessary to use more coats to hide when white or light tints are desired than would be required with light colored priming coats. For the outdoor protection of iron and steel, red lead-linseed oil paint is the best known to the authors. One hundred pounds of dry red lead occupies about 1⅓ gallons; 100 pounds of paste red lead occupies about 2⅛ gallons. Red lead paint can be made weighing more to the gallon than any other paint. The mixing formulas given in Bureau of Standards Circular No. 90 are excellent for metal, and the resulting paints weigh about 25 pounds to the gallon. The drier and turpentine in these formulas cause the paint to flow somewhat more freely than the red lead paints obtained by mixing the pigment with a vehicle composed of boiled linseed oil or one-third boiled oil and two-thirds raw linseed oil. The heavier such a paint is made, the greater protection it gives; on the other hand, the greater is the labor necessary in application. While paints weighing from about 22 to over 30 pounds per gallon (that is, containing from 5 to 2.5 gallons of linseed oil per 100 pounds of dry red lead) are sometimes used on metal, the lighter mixtures are not recommended, and only in exceptional cases should mixtures which are appreciably heavier than the specified formulas be used. In Table 1, formulas numbers 10 and 11 are for straight red lead, and numbers 12 and 13 are for mixtures of white lead and red lead. Formulas 10 and 11 are for steel and iron for first-coat work, to be followed by the same paint but tinted with about three-

fourths pound of lampblack in oil for the second coat [2]; the third or finishing coat may be any good grade of outside paint as given in formulas 5, 9, 19, 24, 29, 33, or 37. Formulas 5, 9, and 19 in white would not completely hide in one coat and should, therefore, be tinted a warm gray by the addition of 8 to 12 ounces of yellow ocher in oil and 4 to 8 ounces of lampblack in oil to every 100 pounds of paste. Formulas 12 and 13, using nearly equal mixtures of red lead and white lead, are excellent priming coats on wood, and two succeeding coats of white paint as given in formulas 4 and 5 or 18 and 19 will practically hide the priming coat.

(*d*) Titanium Pigment, F. S. B. No. 115, B. S. Circular No. 163.—This is not as widely used a pigment as white lead and zinc oxide. It has been on the market only a few years, and its good and bad points are not so well known as the older pigments. Samples should be agreed upon as standard for color and color strength. Titanium pigment should compare favorably in color with white lead. It is exceedingly opaque, but can not be used alone in an exterior oil paint on account of its excessive chalking; hence, in oil paints it is generally mixed with from 30 to 50 per cent of its weight of zinc oxide. It makes excellent enamel paints in varnish vehicles. The only durable white paint for outside use that will retain its color in localities subjected to excessive amounts of hydrogen sulphide is one in which the pigment consists essentially of titanium pigment and zinc oxide. Suitable formulas for such paints are those given in Table 1, formulas 14, 15, and 16, and for such purposes the paints (including any driers) should be free from lead. One hundred pounds of titanium pigment paste will occupy about 4½ gallons, and 100 pounds of the mixed titanium pigment-zinc oxide pastes (60 per cent of the former to 40 per cent of the latter) will occupy about 4¼ gallons.

[2] Semipaste black paint, F. S. B. No. 14, or in fact any dark-colored oil paint that will modify the color of the red lead may be used in place of the lampblack. This change in color of succeeding coats is not made with the idea of improving the quality of the paint, but to make it easy for an inspector to see that the required number of coats are applied.

TABLE 1.—*Mixing formulas using Federal Specifications Board paste pigments, and dry red lead*

Formula number	Paste white lead, Federal Specifications Board Nos. 5 or 6	Paste zinc oxide, Federal Specifications Board Nos. 8 or 9	Dry red lead, Federal Specifications Board No. 11	Paste red lead, Federal Specifications Board No. 11	Paste titanium pigment, Federal Specifications Board No. 115	Raw linseed oil, Federal Specifications Board No. 4	Boiled linseed oil, Federal Specifications Board No. 4	Turpentine, Federal Specifications Board No. 7	Drier, Federal Specifications Board No. 20	Varnish, Federal Specifications Board Nos. 18 or 22	Approximate yield	Used for—
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Gals.*	*Gals.*	*Gals.*	*Pts.*	*Pts.*	*Gals.*	
1	100					3 to 4		2 to 4	1 to 2		7½ to 11	(1)
2	100						7	1[2]			10½	(3)
3	100					7		1[2]	3		11	(2)
4	100					1 to 2		1½ to 2[2]	1		6 to 7	(4)
5	100					3 to 4½		½ to ¼[2]	1		6½ to 7½	(4)
6	100							1½ to 3	¼ to ½	1 to 6	4½ to 6½	(6)
7	50	50				3 to 4		2 to 4	3 to 4		8½ to 11¾	(1)
8	50	50				1½ to 2		2 to 3[2]	4		7¼ to 8¾	(4)
9	50	50				3 to 4		½ to ¾[2]	2 to 3		7 to 8½	(4)
10			100			3½		¼[2]	2½		5¼	(7)
11				100		3		¾[2]	2½		5¾	(7)
12	60		40			2 to 4		1¾ to 2	1 to 2		6 to 8¼	(1)
13	60			40		1¾ to 4		1¾ to 2	1 to 2		6 to 7	(1)
14		40			60	4 to 4½		2 to 4	4 to 5		10¾ to 13½	(1)
15		40			60	2 to 2½		2 to 3[2]	4		8¾ to 10¾	(4)
16		40			60	4 to 4½		½ to ¾[2]	4 to 5		9¼ to 10	(4)

[1] For first (priming) coats, wood, new work.
[2] Volatile mineral spirits F. S. B. No. 16 can be used in place of turpentine in this formula.
[3] For first (priming) coats on plaster, concrete, cement, brick, and stone, new work.
[4] For body coats, wood, outside, new, and first coat repainting.
[5] For finish coats, outside.
[6] For finish coats, inside, flat to eggshell gloss.
[7] For first (priming) coats on metal.

NOTE 1.—In nearly all of the above formulas, except for priming coats on new wood, a mixture of one-third to one-half boiled linseed oil and the remainder raw linseed oil may be substituted for the raw oil, omitting the drier.

NOTE 2.—In using the mixing formulas read across the page on the horizontal line; for example, formula No. 9 reads thus:

50 pounds paste white lead,
50 pounds paste zinc oxide,
3 to 4 gallons raw linseed oil,
½ to ¾ gallons turpentine,
2 to 3 pints drier.

7 to 8½ gallons of paint, for finish coats, outside.

(*e*) OCHER, F. S. B. No. 12, B. S. CIRCULAR No. 91.—Yellow ocher is used primarily as a tinting color. It is advisable to purchase it in oil, and since there are wide differences in color, tone, and color strength in different lots of ocher it is of the greatest importance to agree upon a sample as standard for these points.

3. MIXED PAINTS

(*a*) FOR GENERAL USE.—1. *White paints and tinted paints made on a white base, semipaste, and ready mixed. F. S. B. No. 10, B. S. Circular No. 89.*—This specification covers linseed oil paints. With tints it is necessary to agree upon a standard sample for color only. A great variety of tints, and, in fact, nearly all colors except very dark ones, can be had in paint meeting this specification. Such

paints are suitable for a great variety of work for both outside and inside exposure. The ready-mixed paint as received is intended for final coats (one coat job). It is known that the best proportions of pigment and vehicle for a final coat job are not necessarily the best proportions (frequently are not) for priming or intermediate coats. One of the greatest advantages of a system of painting, such as the use of white lead mixed on the job, is the ability to properly proportion the pigment and vehicle for the different coats. While this can not be done in the best possible manner to meet all painting conditions, with the ready-mixed paint under this specification it can be done with the semipaste; hence, with painting that requires more than one coat and when the work is under skilled supervision, it is advisable to purchase the semipaste. The semipaste will vary somewhat in weight, but 20 pounds per gallon is about an average figure. One hundred pounds of semipaste will occupy about 5 gallons. Formulas 17, 18, 19, 20, and 21 in Table 2 show some of the various uses of the semipaste in making lead-zinc mixed paints.

When skilled supervision is not available, it is frequently best to use the ready-mixed paint, since this paint as received is suitable for the finish coat, and the manufacturer's labels frequently give simple directions for reduction for the priming and body coats. These directions should be followed when given. In the absence of more specific directions add for priming coat on soft porous wood to each gallon of paint about one-half gallon of raw linseed oil and about 1 pint of turpentine; on hard or resinous wood about 1 pint of raw linseed oil and about one-fourth gallon of turpentine. For body coats add about 1 pint of turpentine or mineral spirits to a gallon of paint, and for finish coats use paint as it comes from the can. Drier should not be added to ready-mixed paint.

2. *Iron oxide and iron hydroxide paints, semipaste and ready mixed, F. S. B. No. 13, B. S. Circular No. 93.*—Numerous shades of dull red and brown paints can be obtained under this specification. It is advisable to agree upon a sample as standard for color. This type of paint is cheap and durable, being one of the best paints for a final color coat on iron and steel that has received protective coats of red lead. It is the most commonly used paint for metal roofs. It is also excellent for wood when the color is not objectionable; most freight car paints are of this type. The same general remarks concerning the advantages of a system that uses semipaste paints over over ready mixed apply here as in the white paint, see 3, (*a*), 1. The semipaste will vary somewhat in weight; it must be at least 13½ pounds to the gallon, and is not likely to be more than 17½ pounds. One hundred pounds of the semipaste will occupy about 6 gallons. Formulas 22, 23, 24, 25, and 26 in Table 2 are examples of mixing semipaste for various painting jobs.

3. *Black paint, semipaste, and ready mixed, F. S. B. No. 14, B. S. Circular No. 94.*—This is a cheap but durable oil paint and suitable whenever a black linseed oil paint is required. It has such excellent hiding power that on previously painted surfaces a single coat is frequently sufficient; hence, either ready-mixed paint or reduced semipaste can generally be used with equally satisfactory results. The semipaste generally weighs about 11¼ pounds per gallon and must be not less than 10 pounds. The ready-mixed paint generally weighs about 9½ pounds per gallon. One hundred pounds of the semipaste will occupy about 9 gallons. Suitable mixing formulas whenever the semipaste is used are given in Table 2, formulas 27, 28, 29, and 30.

4. *Green paint, semipaste and ready mixed, F. S. B. No. 15, B. S. Circular No. 97.*—This is the common chrome green-linseed oil paint generally used on window blinds, lawn benches, Government letter boxes, etc. Since many shades of green from light to dark can be secured under this specification, it is necessary to agree upon a sample as standard for color. The paint has excellent hiding power on previously painted surfaces, one coat being generally sufficient and seldom more than two coats being necessary. Green paints generally tend to change somewhat in color on weathering; some lots become more bluish and some more yellowish. This seems to be an uncontrollable defect in practically all green paints. The ready-mixed paint or the reduced semipaste can generally be used with equally satisfactory results. The ready-mixed paint generally weighs about 12¾ pounds per gallon, and the semipaste about 16¾ to 17 pounds per gallon. One hundred pounds of the semipaste will occupy about 6 gallons. In Table 2 satisfactory mixing formulas in using the semipaste may be found in formulas 31, 32, 33, and 34.

5. *Olive drab paint, semipaste and ready mixed, F. S. B. No. 137, B. S. Circular No. 165.*—This is a linseed oil paint of excellent durability. Since there are many colors that can be classed as olive drab, it is advisable to agree upon a standard sample for color. The paint is suitable for a variety of uses for both outside and inside work. The ready-mixed paint as received is intended for final coat (one coat job). On account of its excellent hiding power on previously painted surfaces one coat work is frequently satisfactory, but when two or more coats are required and when the work is under skilled supervision it is advisable to use the semipaste. This paste will weigh about 19 pounds per gallon, and 100 pounds will occupy about 5¼ gallons. Suitable thinning formulas in using the semipaste are given in Table 2, formulas 35, 36, 37, 38, and 39. The remarks on the use of ready-mixed paint in the absence of skilled supervision given in the discussion of white and tinted paints made on a white base apply to this paint also.

TABLE 2.—*Mixing formulas using Federal Specifications Board semipaste paints*

Formula number	Semipaste white and tinted, Federal Specifications Board No. 10	Semipaste iron oxide, Federal Specifications Board No. 13	Semipaste black, Federal Specifications Board No. 14	Semipaste green, Federal Specifications Board No. 15	Semipaste olive drab, Federal Specifications Board No. 137	Raw linseed oil, Federal Specifications Board No. 4	Turpentine, Federal Specifications Board No. 7	Drier, Federal Specifications Board No. 20	Varnish, Federal Specifications Board Nos. 18 or 22	Composite vehicle, Federal Specifications Board No. 17	Approximate yield	Used for
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Gallons*	*Gallons*	*Pints*	*Pints*	*Gallons*	*Gallons*	
17	100					1 to 2	2½ to 3	3 to 4			9 to 10¼	(1)
18	100						2 to 3 [3]	4			7½ to 8½	(3)
19	100					1½ to 2	¼ to ⅜ [3]	2 to 2½			7 to 8	(4)
20	100									5	10	(4)
21	100					1½ to 2	¼ to ⅜	2 to 2½	9 to 10		8 to 9	(5)
22		100				1¼ to 2¼	2½ to 3	3 to 4			10¼ to 12	(1)
23		100					2½ to 3¾ [2]	5			9 to 10¼	(3)
24		100				1¼ to 2¼	1¼ to 1¾ [2]	5			9 to 10¼	(4)
25		100					6			5	11	(4)
26		100				1¼ to	1¼ to 1½	5	9 to 10		10 to 11¼	(5)
27			100			1 to 1½	4¼ to 5	4 to 6			14¾ to 16¾	(1)
28			100				4½ to 5 [2]	4 to 6			14 to 14¾	(3)
29			100			4½ to 7	2½ to 3 [2]	4 to 6			16½ to 19¾	(4)
30			100							7 to 10	16 to 19	(4)
31				100		1¾ to 2½	2½	3 to 5			10¾ to 11½	(4)
32				100			2½ to 3½ [2]	5			9 to 10	(3)
33				100		2¾ to 4½	¾ to 1½ [2]	3½ to 4½			12¾ to 15½	(4)
34				100						5 to 7	11 to 13	(4)
35					100	1½ to 2	2½ to 3½	3 to 4			9¾ to 11¼	(4)
36					100		2½ to 3½ [2]	4			8¾ to 9¼	(3)
37					100	1¾ to 2		4			7 to 7¾	(4)
38					100					5 to 6	10¼ to 11¼	(4)
39					100	1¾ to 2		4	9 to 10		8 to 9	(5)

[1] For first (priming) coats, wood, new work.
[2] Volatile mineral spirits F. S. B. No. 16 can be used in place of turpentine in this formula.
[3] For body coats, wood, outside, new.
[4] For finish coats, outside.
[5] For finish coats on porches, floors, decks, stairs, etc. (use F. S. B. No. 18 varnish for exterior work).

NOTE 1.—In nearly all of the above formulas, except for priming coats on new wood, a mixture of one-third to one-half boiled linseed oil and the remainder raw linseed oil may be substituted for the raw oil, omitting the drier.

NOTE 2.—In formulas 21, 26, and 39 the addition of the varnish amounts to about 1 pint to each gallon of paint, the addition of the varnish serves to harden the coat, and give a wear-resisting surface; the varnish should preferably be added to the paint just before using, and F. S. B. No. 18 varnish is recommended.

NOTE 3.—In using these mixing formulas read across the page on the horizontal line. For example formula No. 37 reads:

100 pounds semipaste olive drab,
1¼ to 2 gallons raw linseed oil,
4 pints drier
7 to 7¾ gallons of paint for finish coats, outside.

6. *Red enamel, F. S. B. No. 66, B. S. Circular No. 146.*—This is a varnish paint and is ready for use. It is excellent for either outside or inside work whenever a hard, glossy, tough, and water-resisting coat is desired. The color from different sources will vary but very little, being a brilliant, bright red of the vermilion type, and is extremely durable in sunlight. This enamel has been used with satisfactory results for painting buoys, and whenever a bright signal red enamel is desired its use is recommended.

(*b*) For Interior Use Only—1. *Flat interior lithopone paint, F. S. B. No. 21, B. S. Circular No. 111.*—This is one of the most commonly used paints for interior walls, and is generally designated as "flat wall paint." It can be furnished in white and a wide variety of tints. When tints are called for, a sample for color only (or for color and appearance) should be agreed upon as standard. The liquid in this paint is generally of a varnish-like nature carrying a large amount of thinner. Unlike linseed oil paints, these flat wall paints are applied with as little brushing out as possible, but flowed on like varnish and enamel. They set to touch very rapidly (often within one hour) and dry to practically flat films (some have a slight sheen) free of brush marks, laps, etc. The paint is suitable as a body and finishing coat. For first-coat work, on unpainted walls, the ready-mixed paint should be thinned with at least a quart of boiled linseed oil to every gallon of paint. The paints as received are generally of a heavy consistency, weigh about 16 pounds to the gallon, and have excellent hiding properties.

2. *Gloss interior lithopone paint, F. S. B. No. 67, B. S. Circular No. 147.*—This is an enamel paint having a varnish like vehicle, and drying with an excellent gloss. It does not weigh so much nor does it hide quite so well as the paint just described in above paragraph, but, on the other hand, it gives a film that is more resistant to moisture and withstands washing better than the above-mentioned paint. It is frequently known as mill white, and while cheaper than the highest grades of zinc oxide enamels, it can generally be used with entire success as an interior enamel paint with a glossy finish. It is applied as a topcoat over undercoats of flat paints, such as flat wall paints just described in above paragraph. Various degrees of gloss, such as "eggshell," etc., can be obtained by mixing the two interior lithopone paints. A sample for color and appearance only should be mutually agreed upon as standard in purchasing this gloss paint.

4. VARNISH

(*a*) Water-Resisting Spar Varnish, F. S. B. No. 18, B. S. Circular No. 103.—Varnish meeting this specification can be used for practically all architectural and structural purposes, both exterior and interior, with the exception of work that must be rubbed in a short time. If, however, several weeks can be allowed for drying, this varnish can be rubbed. It should be used for all exterior work and for interior floors when several days can be allowed for drying before using the floor. When this can not be done it may be best to use interior varnish on the floor. All varnishes should be used as received; there is seldom any need or excuse for adding thinner to varnish.

(*b*) Interior varnish F. S. B. No. 22 B. S. Circular No. 117.—When it is desired to rub a short time after applying this varnish may be used, but in general Federal Specifications Boards No. 18 is to be preferred.

(*c*) Asphalt varnish F. S. B. No. 19 B. S. Circular No. 104.—Asphalt varnish is very commonly used on interior ironwork and on both interior and exterior surfaces subjected to high temperatures, such as smokestacks, locomotives, etc., on which any paint will be soon destroyed. Asphalt varnish not only will last as long as paints on such surfaces, but when it is destroyed it burns off clean, leaving an excellent surface for revarnishing. Asphalt varnish should never be applied under or over oil paints.

III. MIXING PAINTS

The various ready-mixed paints are, as their names imply, ready for use without addition of other materials. Pigments, however, always settle to a greater or less extent, and such paints must be thoroughly stirred so as to evenly distribute the pigments in the vehicle. It is generally advisable to pour off most of the clear liquid at the top of the container, thoroughly mix the settled pigment and the remaining vehicle by stirring with a stout paddle; then add a little of the remaining liquid, stir thoroughly, and repeat the process using only a little liquid at a time until the whole is added; in the few cases when additional liquid is required, add it in the same way. After mixing the finished paint, strain through a paint strainer or cheesecloth. With semipaste paints thoroughly mix the semipaste before adding the thinning liquids and add such liquids gradually with thorough stirring. Mix well and strain all paints before using.

White lead paint mixed on the job may be taken as a typical example of thinning paste paints. The paste, which is quite stiff, should be transferred to a vessel large enough to hold considerably more than the volume of paint to be mixed. Then add a small amount of linseed oil, not more than 1 pint to 100 pounds of white lead paste, and mix thoroughly with a stout paddle to a homogeneous softer paste, then add another smaller portion of the oil, mix thoroughly. Repeat this gradual addition of oil and mixing until the paste is thin enough to be easily stirred and can be poured but is still too thick to be used as paint. If any tinting color is to be added, thin it separately to the same consistency, strain, and add it to the partly reduced paste and mix well. When adding tinting colors, add too little rather than too much; these colors are strong, and only very small amounts are necessary to tint 100 pounds of paste white lead. Then add the drier and thoroughly mix. Then with constant stirring work in the rest of the oil, then the turpentine or

mineral spirits. In any formula calling for the addition of spar varnish to the oil paint, such as a floor, porch, or deck paint, add the spar varnish to the completed paint just before application. Generally 1 pint to each gallon of paint for the top coat is ample. Varnish, in general, should not be added to the oil paint and then allowed to stand for several days before using. Some varnishes may thicken up paints containing zinc oxide even overnight. Oil paint is better if allowed to stand a day before using; it should be strained through a sieve or cheesecloth shortly before using.

In mixing paint with two or more pigments, as, for example, white lead-zinc oxide paint or zinc oxide-titanium pigment paint, it is best to break up each paste separately as with white lead to the point where the drier is added, add the drier in portions to each partially broken down paste, mix these, and proceed with the addition of the rest of the oil and volatile thinner as in the case of white lead.

The mixing formulas given in Table 1 are typical formulas. The amounts given are approximately correct for average conditions, but the painter will vary the amounts of the different ingredients according to the nature of the surface, weather conditions, etc. Many other mixtures can be successfully used, and no attempt is made here to do more than give some typical examples.

IV. APPLICATION

1. TO WOOD

(*a*) New Work.—On exterior work the wood, as in all cases, must be clean, dry, and free from grease. The summer, fall, and early winter are generally considered to be the best time for painting, but cold, damp, foggy, or frosty weather, such as in the early morning or late evening, should be avoided. Paint over knots and sappy wood is very liable to peel, and there is no certain method of avoiding this danger. Probably the best precaution is to wash such parts with turpentine immediately before applying the priming coat. New work generally receives three coats of paint; the priming coat, which is the foundation of all successful painting, should be composed of good materials; the paint should be made thin and should carry a large amount of linseed oil and some turpentine to assist penetration. The paint should be carefully and well brushed out to a thin coat and at least two or three days should be allowed for one coat to dry hard before the next is applied; one or two weeks or even longer would be far better; no substitutes for linseed oil or turpentine are recommended in priming coats, except, that benzol (coal-tar naphtha) may replace a part of the turpentine (1 pint to the gallon of paint) on extremely resinous woods, such as cypress. At this point all cracks, nail holes, etc., are filled with a good com-

mercial putty made of whiting and linseed oil, with or without the addition of a small amount of paste white lead.

The second coat should hide the surface to a large extent, and it should dry flat or nearly so. This is accomplished by having the paint contain turpentine or mineral spirits and considerable pigment. The final coat should contain nothing but linseed oil with the least amount of drier necessary for the paint to dry within 18 hours. Paints made with soft pigments, such as white lead, may also have a small amount of turpentine; the coat should dry within 18 hours to a full oil gloss.

(*b*) Repainting Wood.—Whenever the surface is satisfactory for repainting, two coats are sufficient, the old paint surface constituting the priming coat, and paint for second-coat work on new wood should be applied to the clean surface. All loose and scaling paint must first be removed, any puttying follows this coat, and the final coat, which is the same as the final coat on new work, is then applied. Very often one coat of third-coat paint is sufficient for repainting jobs.

2. TO METAL

Paint is applied to metal, chiefly to prevent corrosion, and, in general, should be well brushed out to avoid any runs, or sags, since little or none of it penetrates into the metal, unlike priming coats on wood. Pure red lead is recommended as the priming coat after first making sure that the surface is free from dirt, rust, scale, grease, and other foreign matter. Three coats of paint should be used on exterior work for the best results and two or more coats for interior work. The priming coat should be given plenty of time to dry, a week if possible. This paint may be followed by one or more coats of any of the paints specified for outside use. The painting of galvanized iron, zinc, tin, copper, and other metal surfaces sometimes gives trouble. In general, it is essential that all grease be thoroughly removed from these surfaces by using benzol or gasoline on a rag. New galvanized iron and zinc may offer special difficulties, and after cleaning the metal a priming coat composed of 2 ounces of copper chloride, copper acetate, or copper sulphate in one-half gallon of water should be applied and allowed to stand overnight, and then dusted off and a coat of red lead applied. This treatment will not always prevent paint from peeling on galvanized coatings, but is the best treatment known to the authors. A still better plan is to allow the untreated galvanized iron or zinc to remain unpainted for six months, or better a year. Iron oxide paints are also widely used for painting tin roofs, metal sidings, etc. The priming coats on these metal surfaces should be especially well brushed out and well worked into the metal to avoid peeling. Experience indicates the advisability of thoroughly washing copper roofing, sheathing, rainspouts, etc., with

160° benzol before applying paint. Two or more coats of spar varnish applied to new copper free from any grease will offer good protection against change of color by weathering. In general, paints will dry more slowly on copper than on other surfaces.

3. TO CEMENT, PLASTER, CONCRETE, AND BRICK

Too much emphasis can not be laid on the thorough drying of all plaster, concrete, cement, etc., before painting. It must be remembered that such structures when new contain much water, and unless sufficient time, under proper conditions of temperature and humidity, is allowed for thorough drying the water remaining in the wall will eventually seriously injure any paint coating. It should be pointed out that a wall may appear to be dry on the surface but be still damp in the interior. Even when properly dried, new structures of this kind may contain free lime; hence, it is advisable when the structure is less than a year old, even if it is known to be dry, to apply before painting, an aqueous solution of zinc sulphate (3 to 4 pounds crystallized zinc sulphate to 1 gallon of water). Allow this to thoroughly dry before applying paint.

Old plastered walls should be washed with soap and water containing a little ammonia; old whitewash or cold water paints must first be removed before applying oil or varnish paints. New or unpainted plaster or old paint should be lightly sandpapered with fine sandpaper, and all cracks and holes should be filled with plaster of Paris. The smooth and clean surface can then be painted either with white lead or with the prepared paints covered by Federal Specifications Board Nos. 21 and 67 paints. In using these prepared wall finishes the new wall should first receive a coat of thin paint, made by adding 1 quart or more of boiled linseed oil to each gallon of Federal Specification Board No. 21 paint; this can be followed by a size coat of interior varnish (F.S.B. No. 117) thinned with turpentine, and to which has been added some of the finishing coat mixed paint to give color, or some finishing coat paint thinned with interior varnish and turpentine may be directly applied, followed by a finishing coat from the can. Two coats of these flat wall paints are often sufficient on unpainted walls, the first coat being the paint thinned with boiled linseed oil (1 quart to the gallon). Each coat should be allowed ample time for drying, at least overnight, although some of these paints surface dry within one hour. For gloss finishes, one coat of Federal Specifications Board No. 67 paint should be applied over two coats of the flat paint. For satisfactory results, these paints should not be brushed out like ordinary linseed oil paints, but should be flowed on like varnish and enamel, and then left alone; the good grades, either flat or gloss, will level up themselves and will present a surface at the end of two or three coats that is smooth and free from laps and brush marks.

Cement and concrete surfaces, after being treated with the zinc sulphate solution and allowed to dry, can be painted the same as wood, using either white lead, mixtures of white lead and zinc oxide, or any of the specification paints; the priming coat should contain some boiled linseed oil.

New brick surfaces after receiving the zinc sulphate wash should be primed with a coat of boiled linseed oil, and then painted like wood.

4. BRUSHES AND BRUSHING

In connection with the application of paint, something should be said concerning the care and selection of paint brushes and the brushing of paint.

In the brushing of paint on metal, too much emphasis can not be laid on the importance of thoroughly brushing out the paint to thin coats. This will, to a great extent, affect the durability of the paint in wearing and protecting the surface. On all surfaces, and especially on wood, the oil paints should be well brushed out according to good painting practice, and well brushed into the wood. Oil paints should never be flowed on or applied as one would wash a floor with a mop. On the other hand, varnishes, enamels, and enamel paints, such as flat and gloss wall paints (F.S.B. Nos. 21 and 67), should be flowed on with as little brushing as possible.

Cheap brushes will not do good work. A good grade of brushes, in sufficient quantities, should be used. A new brush may be washed out with turpentine or mineral spirits before using, but never with water. If the brush is to be used daily, it may be allowed to remain overnight full of paint on a board or be wrapped in several thicknesses of paper. Brushes that are to be used only from time to time, but at short intervals, should be kept suspended in a paint trough and never allowed to stand on end or be kept in the paint. The paint trough, which may be a deep pail, fruit jar, or the kind for sale at paint stores, is filled with linseed oil or turpentine, or what is cheaper and just as good, kerosene. The brushes are immersed so that the bristles and about 1 inch above the bottom of the ferrule are covered with the liquid. The brush is thus kept usable; never keep brushes in water. Brushes that are kept in kerosene may be washed with mineral spirits just before using. In putting brushes away for long lengths of time, the fresh paint should be well washed out with kerosene (turpentine will do, but is more expensive), given a rinsing with mineral spirits or benzine, and either then put away or washed with soap and water, shaken, and then allowed to dry before putting away. Varnish brushes should be kept in the varnish if in daily use, but for longer periods should be kept suspended in kerosene, and washed out with turpentine when needed for use.

Paint brushes which have become hard and dry with the paint, may be cleaned by long soaking in kerosene followed by soaking in a mixture of three parts of benzol and two parts of acetone (or a commercial paint and varnish remover), and thorough brushing on a rough board. Then clean the brush in benzine or mineral spirits.

An excellent book of instruction for apprentice and journeymen painters is entitled "Painting and Decorating Working Methods," issued by A. H. McGahn, secretary of the International Association of Master House Painters and Decorators of the United States and Canada, 1511 Eleventh Street NW., Washington, D. C.

WASHINGTON, August 20, 1924.